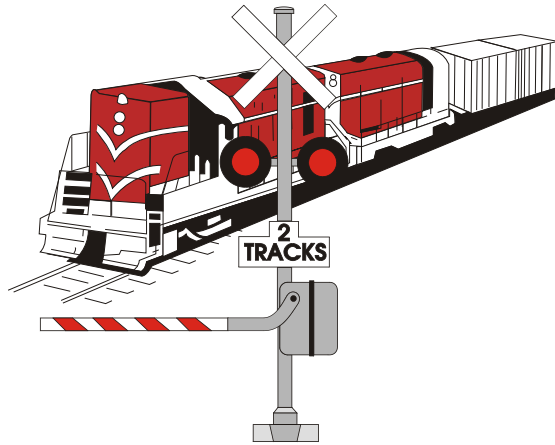


Evaluation of the Automated Wayside Horn System in Mundelein, Illinois Final Report



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Executive Summary

Highway-Rail Crossing Safety and Train Horns

At highway-rail grade crossings, the train horn serves to warn motorists of a train's immediate approach. The horn advises motorists, and other crossing users such as bicyclists and pedestrians, that entering on or crossing the tracks would place them in imminent danger. However, because of the loudness and the wide angle of sound radiation, the horn can be an intrusive nuisance, especially in residential areas near the tracks. As a result, an automated wayside horn system (AWHS) has been developed to provide an appropriate warning for those using the crossing, while not annoying those living near the tracks.

A study was carried out in Mundelein, Illinois, that compared the train horn with the AWHS. This report compares motorists' driving behavior at highway-rail crossings and the sound levels of the two types of horns. The results from the evaluation show a significant 70% decrease in violations of highway-rail crossing law with the AWHS. Noise levels in areas near the tracks decreased by up to 85%.

Reducing the number of collisions between vehicles and trains has remained a priority in highway safety. During the past 10 years, collisions nationally have decreased from 4,684 in 1992 to 3,064 in 2001 (Federal Railroad Administration). During this same period, all collisions with trains in Illinois remained fairly constant with an average of 232 per year. Even though there has been a general decrease nationally, these collisions remain the most severe type in terms of producing injuries and fatalities. Crossing gates have the best record at reducing collisions, but a study done in Florida showed that even with crossing gates, a train horn still is needed. The Federal Railroad Administration (FRA) has proposed rules to require that horns be used at all crossings with few exceptions that are expensive to implement. The problem remains that the train horn, which, in Mundelein, starts sounding approximately 17 seconds before the train reaches the crossing, creates very high sound levels in adjoining areas.

As a result of the need to alert motorists and at the same time reduce the effect of sound on adjoining areas, Mundelein experimented with the use of the AWHS. The study reports the results of the evaluation of the AWHS.

Conduct of the Study

Five tasks were undertaken: site preparation, before and after motorist violation studies, before and after sound studies, quality-of-life studies, and surveys of engineers and residents.

At each of the three sites used for studying motorist behavior, utility poles were erected, and cameras and recording equipment installed. The recorders activated when the warning signals activated, thereby recording what motorists did during the period the gates were descending and down before the train arrived.

Drivers are considered to be taking risks (and violating the law) when they attempt to cross the tracks after the crossing gates start to descend. This action was measured by viewing videotapes made at each crossing during the period the gates were activated. Data were taken during the period train horns were in use, then after a period of adaptation, when the wayside horn was in use. The violations were divided into two classes:

Technical violation where the driver crosses the tracks after the gates start to descend but before the gate has been lowered sufficiently to block the vehicle's passage, labeled a "Type 1" violation, and

Deliberate violation in which the driver either drives through or around the lowered gate. These are "Type 2" violations.

Loudness and sound characteristics were measured on approaches to several crossings with train horns in use and then after the wayside horns were activated. A comprehensive assessment of these measures is contained in a separate report; this final report just summarizes the findings.

Measures of quality-of-life derived from two sources: sound studies in residential yards and a survey of the residents. The project team measured sound levels over 24-hour periods at nine locations throughout Mundelein. These measures were made during the period when train horns were used and again after the wayside horns were placed in service. Comparisons included the average sound level in one-second periods, during the time that horns were sounded, and a sound exposure level. The latter takes into account duration and allows direct comparison of sounds between different locations and over different periods.

In addition, surveys were sent to a sample of residents in Mundelein. The survey asked residents how they viewed the new horn system compared to the train horns. Several questions also were directed toward the residents' views of changes in crossing safety.

Finally, a survey was distributed to engineers from both the freight railroad (Canadian National) and commuter rail (Metra). This survey was modeled after the one used in Ames, Iowa, for a

similar evaluation. It asked the engineers how they perceived the crossing safety before and after the wayside horns were activated.

Evaluation of Changes in Crossing Violations

From the period September 8 through December 20, 2001, 10,392 gate activations were recorded on videotape at three crossings. During the second period of observations, April 12 through July 16, 2002, 9,112 activations were recorded. Each period averaged 36 closings per day or 3.5 per 1,000 crossing vehicles. The largest percentage of closings, 17%, occurred from 6:00 p.m. through 9:00 p.m.

A total of 367 violations were counted during the period when train horns were in use. Only 97 violations were recorded once the wayside horns were in operation. The average violation rate when train horns were in use was 3.53 per 100 gate closings. This decreased 68% to 1.12 per 100 closings with the AWHs. The decrease is statistically significant. Type 1 violations (driving under a descending gate) occurred 358 times in the before period and 93 in the after period. A combined total of 13 drivers in both periods went around a gate. With few exceptions, most of the Type 1 violations occurred within the first two seconds after the gates began their descent.

Of the Type 1 violations recorded when train horns were in use, more than 90% occurred between 6:01 a.m. and 9:00 p.m. Between 12:01 and 3:00 p.m., 30% of all violations occurred. The largest percentage occurred on Hawley Street. Part of the problem stems from multiple gate activations when Metra commuter trains stop at the Mundelein station near Hawley Street.

A total of 13 instances were recorded where motorists drove around the gates. Nine occurred during the time the train horn was in use, and four occurred when the AWHs was operating. The decrease is not statistically significant. Approximately one-half of the violations happened when a train arrived during the 60-second recording interval. In one case, a driver cleared the tracks just 6 seconds before a freight train arrived. On the average, 17 seconds separated the vehicle from the train. At 50 mph, a train would just have passed the whistle post; therefore, the motorist driving around the gates generally might not yet have heard a train horn if train horns were being used. As with Type 1 violations, a large percentage of Type 2 violations occurred in conjunction with Metra commuter operations.

One problem uncovered with the gate operations was gate closure without a train present. Often, this is referred to as a "false activation." These activations comprised approximately 13% of all closings. Metra stops at the Mundelein station and switching operations accounted for a majority of these activations.

Finally, an unusual situation was videotaped during the spring of 2002 in which drivers stopped on the tracks in an apparent response to the wayside horn sounding without prior warning. This happened on 12 occasions. When the drivers went forward, they generally cleared the tracks after the gates had closed just behind them. In other words, in most cases, the drivers occupied the tracks for 12 or more seconds. In one case, a driver backed up, just clearing the descending gate.

Survey of Residents and Engineers

Two sets of surveys were distributed to examine opinions of both the wayside horn and its perceived safety effectiveness. The respective surveys were administered to more than 1,250 Mundelein residents and to railroad engineers for both the Canadian National Railroad and Metra Commuter Rail.

Residential survey. The 229 residents who responded to the residential survey, by a substantial majority, found the wayside horn much less annoying than the train horns. The exception was persons who lived close to and in a direct line with the wayside horn. More than 15% of respondents found the wayside horn annoying, and a slightly greater percentage responded that “occasionally” the horns interfered with their activities. When compared to the train horn, 88% found the wayside horns either less loud or not even noticeable. A similar percentage also found them less annoying.

When asked about safety, approximately 9% suggested that they were less safe. The same percentage believed that motorists would be more likely to violate crossing laws. On the other hand, the remainder of the respondents believed that the crossings were as safe or safer with the wayside horn than they had been with train horns.

Engineer survey. Both Metra and Canadian National engineers also responded to surveys. One Canadian National and one Metra engineer believed that the crossing was less safe. Neither gave a reason for selecting that answer. However, both also did not like the method of notifying the engineer when the horns were not working. The remaining engineers believed the crossings to be as safe as or safer than when they used the train horn.

Analysis of the Sounds from Train and Wayside Horns

The key element of the evaluation addressed the differences between the train horn and the wayside horn as it might affect safety of the highway-rail crossing. For the village residents, it was of equal importance to compare how the two horns affected their lives. The findings are discussed in greater detail in a separate report produced as part of the project.

In terms of outcomes, the sound level of the wayside horn was equal to or exceeded that of the train horn for a driver approaching a highway-rail crossing. The exception was when the train reached the crossing, where the train horn was louder. This finding held for a motorist approaching the crossing, whether at the last point where the motorist could stop safely or at the sign warning the motorist of the approaching crossing. The two horns had similar frequency components and were of equal loudness at different frequencies. Perhaps the greatest difference was that the wayside horn is produced electronically and the train horn by air passing through tuned horns. As a result, the sound of the wayside horn had a certain artificiality.

The wayside horn had a significant impact on the quality-of-life in areas near the crossings. At the highest decibel levels, the wayside horn covered 85% less land area than the train-mounted horns. Even at lower levels, more than 65% less area was affected. The residential survey clearly bore out the findings from sound measurements. On the other hand, some persons were affected more than before. Some of this occurred because the pattern of the sound dispersion changed. Volume levels were elongated along the roadway so that some persons heard a louder horn than before. More importantly, because the horns were of constant volume and lasted longer than the train horn, this increased their apparent loudness.

Summary and Other Issues

This evaluation of the automated wayside horn system (AWHS) compared the new system to the train horn. It examined three elements for differences:

1. Motorist violations of the law governing gated highway-rail crossings along with perceptions of its safety from drivers and railroad train engineers.
2. The nature of the sound heard by the motorist and the potential effects of any differences on safety at the highway-rail crossing.
3. Quality-of-life for residents as measured both by sound levels, and how the residents perceived the loudness and annoyance of the two warning devices.

With the introduction of the AWHS, motorists' violations of the crossing gates decreased 68%. This difference had less than a 0.0001 likelihood of occurring by chance. The largest change came from Type 1 violations or driving under the closing gates. Because so few motorists drove around the gates during the period the train horns were in use, the decreases occurring during the after period could not be said to be statistically significant. In responses to the surveys, both engineers and residents indicated that they believed the wayside horn created a safer crossing environment for motorists. Because there were no other known changes to the operation of the roadways, the wayside horn is the most likely factor in the reduction of violations.

The sound studies showed that, in terms of nature and quality of sound, what the motorist heard from the wayside horn was generally no different from what he or she heard from the train horn. However, there were two differences in sound delivery. The first was that the train horn provides a sense of movement because it gradually increases in volume. The wayside horn starts and remains at a constant volume. The second difference was that the wayside horn sounds when the crossing warning lights first activate while the train horn is usually not heard until the gates are fully descended.

Residential quality-of-life, as measured by the noise levels in the crossing areas, improved significantly with the AWHs. At all levels, from 70 to 90 decibels, the reductions in area covered by a given decibel level, ranged between 65% and 85%. When residents living near the crossings were surveyed about the wayside horns as compared to the train horns, more than 80% of the respondents indicated that their quality-of-life had improved.

Finally, in referring to Type 2 violations (driving around the closed gates), none occurred at Allanson Road. At this crossing, there is a 6-inch raised concrete median that extends approximately 40 feet back from the tracks. While this does not quite meet the proposed FRA standards, it appears to have been sufficient in preventing drivers from going around the gates. Except for the two drivers on Maple who drove around the queue waiting for malfunctioning gates, all of the drivers who went around the gates were the first vehicles in line. Restricting the driver's ability to pull out around the gates for between 30 and 40 feet back from the gate, along with the presence of the wayside horn, probably would eliminate almost all Type 2 violations.

The conclusion then drawn from this study is that the wayside horn significantly reduces highway-rail crossing violations. It accomplishes this task while improving the quality-of-life for nearby residents.